Volume 22 April, 1936 *Number 4*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Lubrication and Maintenance of Highway Machinery

PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

TEXACO LUBRICANTS FOR
HIGHWAY CONSTRUCTION EQUIPMENT

SHOVELS, DRAGLINES AND OTHER GRADING UNITS

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*Of a grade commensurate with operating temperatures and type of housing.

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THE TEXAS COMPANY, 135 East 42nd St., New York, N. Y.

LUBRICATION

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Published by
The Texas Company, 135 East 42nd Street, New York City
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Vol. XXII April, 1936 No. 4

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Lubrication and Maintenance of Highway Machinery

IN the operation of highway or road building equipment there is a definite relationship between machinery performance and the volume of material that can be handled, for maximum production in this field depends upon maintenance of power shovels, trenching machines, back fillers, drag line scrapers, concrete mixers and rollers.

Maintenance is essential to correct the effects of wear. The extent to which wear may occur depends on lubrication. Consequently, maintenance also will be very largely contingent upon lubrication. Since this latter is most effective in reducing wear, it follows that it is also instrumental in reducing maintenance costs.

On a road building job the majority of the heavy work is done by the excavating machine. If it is not mired down in mud it is expected to climb rock piles, range through trenches, and transform the countryside by cutting down hills and filling valleys with equal ease. All this imposes severe duty upon the moving parts. Very often this is not realized by operators, but there is a limit to what any mechanical device can do. Furthermore, when the breaks do come, they very often result in serious injury to the operator, for a parted wire rope, a broken gear, or engine failure will do considerable damage throughout the machine. When this occurs operation and maintenance costs rise to an abnormal degree. When working under contract time limits may be exceeded, leading to costly penalties.

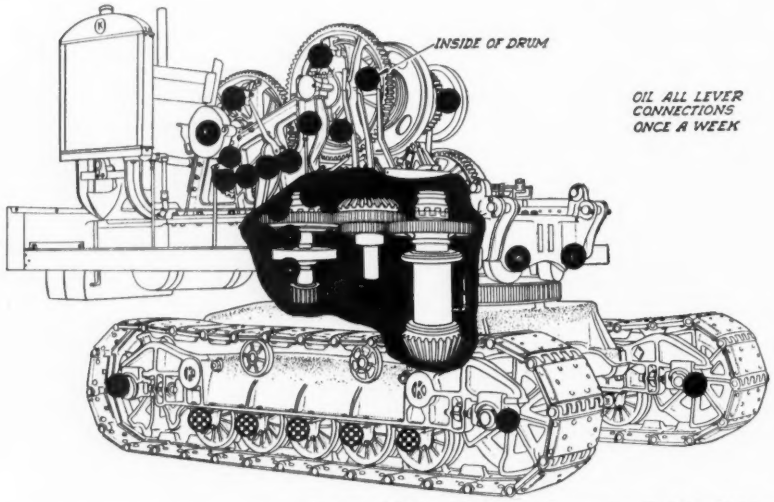
Careful study of wire rope, gear, bearing and engine lubrication is the safest form of insurance that the job will be completed with economy, expedience and profit, and that machinery will be ready and fit to tackle the next one to the same ends.

While road building machinery is grouped into a number of classifications, as already mentioned, according to the nature of the duty required, they all perform the same broad function—the handling of materials to or from the work, or the loading of such materials into cars or trucks. All this involves exposure to dust, dirt, rain, mud, and sometimes snow. Corrosion and abrasion between wearing elements will, therefore, tend to occur to a marked degree.

The fact that this holds true regardless of the parts involved renders it difficult to discuss the lubrication of any of these parts from a priority point of view. They are all important, and all subject to wear and rapid deterioration if not properly lubricated; also, they all entail hazards and costly repairs in the event of failure.

Normally, gears, chains and wire rope must operate more continuously with restricted lubrication than any of the other wearing elements. This will lead to increased power con-

sumption and ultimately considerable labor, time and material costs when replacement is necessary. Obviously where lubrication is restricted or neglected, replacement ultimately becomes necessary if the machine is to continue in operation.



Courtesy of National Equipment Corporation, Kochring Division.

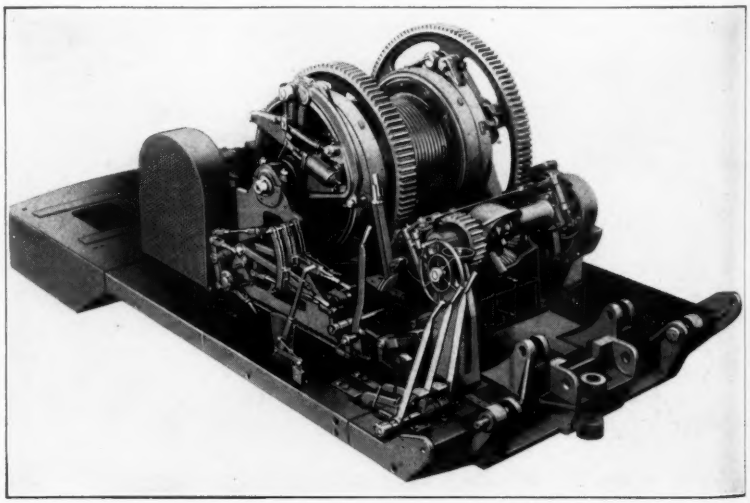
Fig. 1—Lubrication diagram for the mechanisms on a Kochring Shovel-Crane-Dragline. Means for grease lubrication are extensively provided for on this unit, as indicated by black and checkered circles.

STEAM POWER EQUIPMENT

Steam operated equipment must be studied from the viewpoint of the nature of the steam used, for pressure and moisture content will materially affect lubrication. As a rule, steam pressures will be comparatively low, ranging in the neighbo hood of 150 pounds per square inch. Furthermore, there will usually be considerable condensation, due to the exposed nature of many of the steam lines. This can be partially counteracted by taking steam from the highest part of the boiler and judicious application of insulating pipe covering. Even with these precautions the steam, as delivered to the engine, is often relatively wet. This will be all the more true where pipe covering or engine or boiler insulation is allowed to become frayed, torn or loose in parts, as will often happen where steam shovels, etc., are subjected to hard service and allowed to remain exposed to the weather. Cylinder condensation will also be prevalent where engines operate intermittently.

As a result water will almost always accumulate above the throttle valves prior to starting the engines, the amount depending upon the length of time they have been stopped. Now, if the cylinders are not covered with a tenacious film of properly compounded lubricant, the admission of these slugs of water will tend to wash the oil from the wearing surfaces, and for the next few strokes insufficient lubrication will be probable and scoring and abnormal wear may occur. The constant repetition of the above will not take long to produce compression losses and inefficient operation of the entire machine, due to steam leakage past the piston rings. Groaning of the engines or rattling of the valves on their seats may also occur in extreme cases. This will decrease the power available and lead to increase in fuel consumption to meet operating requirements.

Cylinder oils should, therefore, be selected most carefully to be sure they contain sufficient compound or animal fat to give the requisite tenacity to the lubricating film, and possess adequate viscosity to withstand prevailing cylinder temperatures. A viscosity of approximately 130 seconds Saybolt at 210 degrees Fahr., and the addition of from 6 to 10 percent



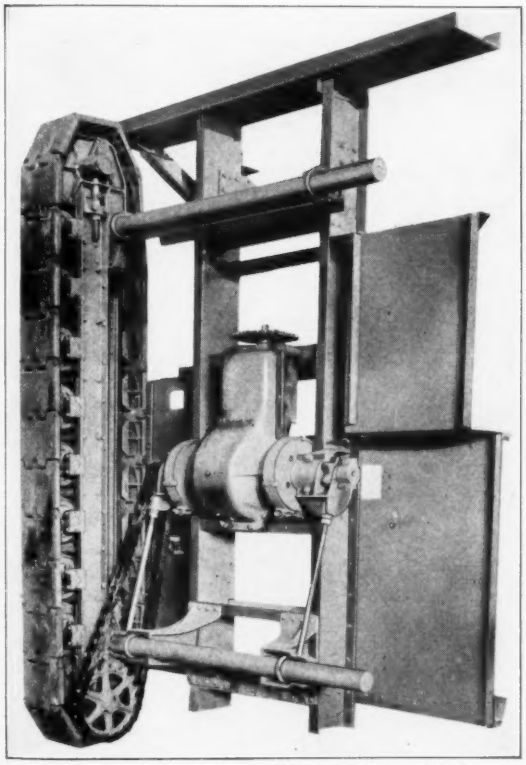
Courtesy of Bucyrus-Erie Company

Fig. 2—Revolving frame machinery of the Bucyrus-Erie Diesel unit.

of compound will normally assure of effective lubrication, and ability to resist the washing action of any water that may be present in any part of the system.

Delivery of cylinder oils to the steam line of any such engine should be made at a point from 4 to 6 feet back from the throttle valve, although the crowding engine may require oil delivery at a point further back. Either a hydrostatic or mechanical force feed lubricator can be used for this purpose. The mechanical force feed lubricator is the more positive and economical, since its operation is contingent upon the operation of the engine. Regardless of the type used, however, the oil must be fed into the steam line via a suitable atomizer to bring about thorough atomization, and to enable the steam to carry the oil in fine particles throughout the engine.

If the point of introduction is located too close to the throttle valve or cylinder, complete atomization may not take place; if too far away there will be a possibility of the oil particles being thrown to the walls of the steam line,

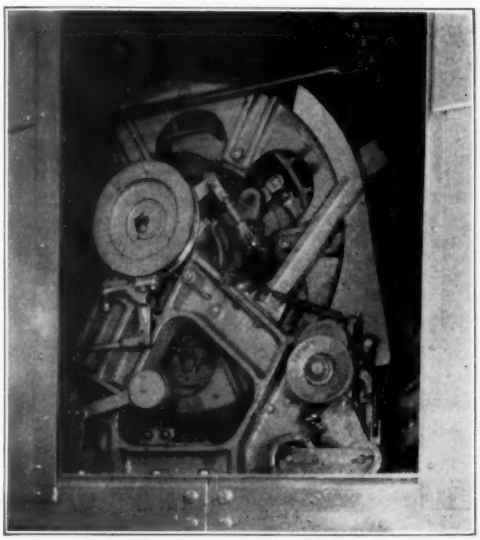


Courtesy of Chain Belt Company

Fig. 3—Under-frame and drive unit for the Rex Paver.

from whence a flow of liquid lubricant will occur to the valve chest. In effect, this might well be termed condensation of the lubricant; it may be quite considerable if there are any bends or other pipe fittings located between the lubricator and the valve chest.

The steam itself becomes an adjunct to cylinder lubrication provided the lubricant is sufficiently atomized to enable complete dispersion. Virtually, the steam becomes the carrier



Courtesy of Link-Belt Company

Fig. 4—View of the operating machinery on the rotating frame of a Link-Belt Crawler Gas Shovel showing convenient location of the pressure lubrication fittings.

to bring about the most thorough distribution of oil to all moving elements inside of the valve chambers and cylinders. If the oil is divided into minute globules and intimately mixed with the steam, only a very small quantity is required; the subsequent degree of atomization controlling both the efficiency of lubrication and the quantity of oil required.

To meet average operating conditions steam cylinder oils for highway construction machinery must have comparatively heavy body and be of a particularly adhesive nature in order to insure the maintenance of a lubricating film which will resist the wearing or scraping effects of the average valve and piston, and washing off by the steam itself.

Bearings

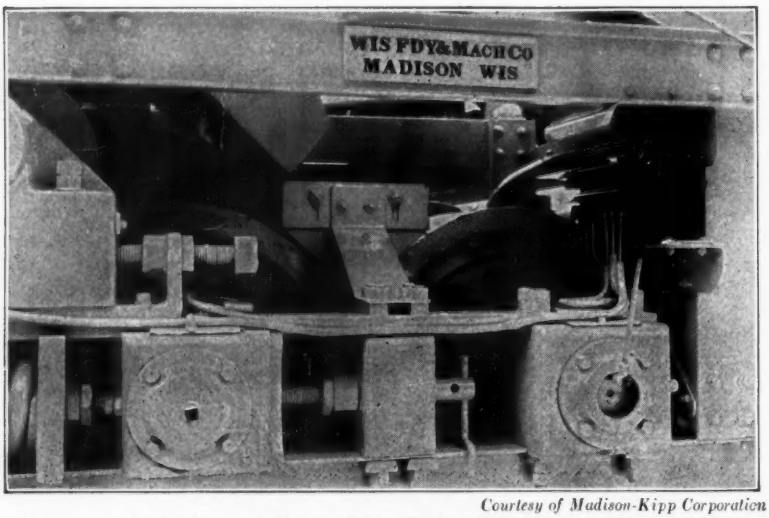
Bearings are lubricated by compression grease cups, or hand oiled. Conditions are not conducive to effective bearing lubrication due to the exposed nature of so many of the bearings. To counteract the possibility of dust, dirt, water and abrasive matter penetrating within bearing clearances, the compression grease cup or pressure gun is preferred by many.

It is not best practice to resort to cheap, inferior lubricants such as black oils, for these will not give complete protection to many of

the bearings which are carefully adjusted and designed for small clearances.

GASOLINE AND DIESEL ENGINE POWER

Where the internal combustion engine is used, power plant lubrication is more centralized, in view of the fact that normally but one grade of engine lubricant is required, as in the automotive engine. In other words, the Diesel and gasoline engines, as adapted to present day highway construction machinery, are so designed as to be effectively lubricated by the same oil for both cylinders and bearings. It is particularly advantageous to use an oil of this type and avoid the necessity of stocking more than one grade for the power plant, for in many localities, handling of supplies must be reduced as far as possible.



Courtesy of Madison-Kipp Corporation

Fig. 5—View showing force-feed oiler on a Badger Crushing Roll of Wisconsin Foundry & Machine Company design. The 7-feed Madison-Kipp lubricator serves the main bronze bearings of the roll shafts, the bearings on the counter shaft and the drive chain from the counter shaft to the rolls.

With the added proviso of positive and automatic circulation of oil throughout the period of running of the engine, the only operating precautions will involve:

(a) Regular routine for checking the oil level to take care of replenishing any oil lost by vaporization.

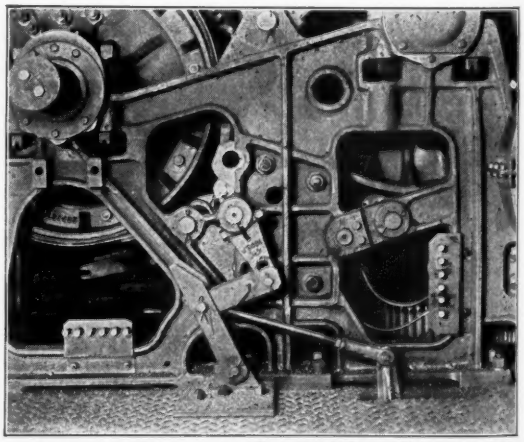
(b) Draining of the crankcase at periodic intervals according to builders recommendations and the severity of the service, and

(c) Care in selection of the oil supply to make sure it possesses properties suited to the service.

In this connection, carbon residue content, viscosity and pour test are of primary importance. Oils showing low carbon residue are best suited to either the Diesel or gasoline type engine, for this insures against accumulation of objectionable carbon residues around piston rings, in cylinder heads or around valves, any or all of which might readily reduce power output and the efficiency of the engine. Viscosity and pour test, in turn, are important in cold weather service, for they are indicative of fluidity. Low pour test oils within the S.A.E. 20 to 30 viscosity range should meet normal cold weather conditions and flow readily to the pump the instant the engine is started.

Warm weather operation, on the contrary, requires the use of heavier bodied oils, for higher temperatures tend to thin down any petroleum lubricant. Here one should use an oil of the S.A.E. 40, 50 or 60 range, dependent on the size and speed of the engine, its operating temperature and method of cooling.

Translated into the usual terms of viscosity, this would mean that for temperatures below approximately 20 degrees Fahr., an oil having a viscosity of from 300 to 550 seconds Saybolt at 100 degrees Fahr., will normally be suitable. For temperatures above this dividing line the oil should be somewhat heavier, of a viscosity range from say 75 to 100 seconds Saybolt at 210 degrees Fahr.



Courtesy of Harnischfeger Corporation

Fig. 6—Close-up view of the Harnischfeger Centralized Lubricating System as adapted for power shovel service. The accessibility to the operating platform is plainly shown.

The gasoline or Diesel engine is of more intricate construction than the average steam engine designed for such service. As a result more care and attention in regard to mainte-

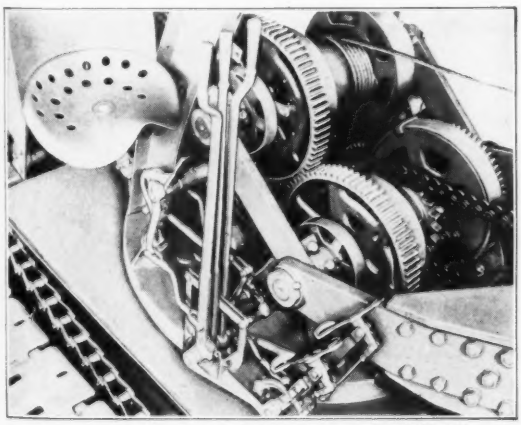
nance and lubrication is necessary. For this reason every effort has been exerted by the designers to develop means of lubrication which will be as completely automatic as possible.

Full pressure or a combination of splash and force feed lubrication is usually employed in the gasoline engine, the oil being handled by a gear pump, driven by the main shaft of the engine, or, in some instances by a mechanical force feed lubricator. The latter is advantageous in that fresh oil is delivered to the cylinders and main bearings, drop by drop. This overcomes the difficulty of possible dilution, for fresh oil of the right viscosity is fed constantly to each bearing and cylinder.

This method of lubrication is very similar to that so commonly employed on many types of Diesel engines today. The oil flow is accurately controlled in its intensity, as well as in its starting and stopping, since the lubricator pumps are driven by the engine. It must not be assumed, however, that the efficiency of such an engine is solely dependent upon lubrication. Other factors, such as the fuel and its manner of combustion, the grade of lubricants used, the extent to which proper cooling is brought about, and the perfection of design will all affect power development.

Gasoline Engine Service

Extremely exacting requirements are imposed upon both the oil and lubricating system in any gasoline engine subject to construction operating conditions. Certain of these are so important as to require discussion in detail. A better realization of their importance will

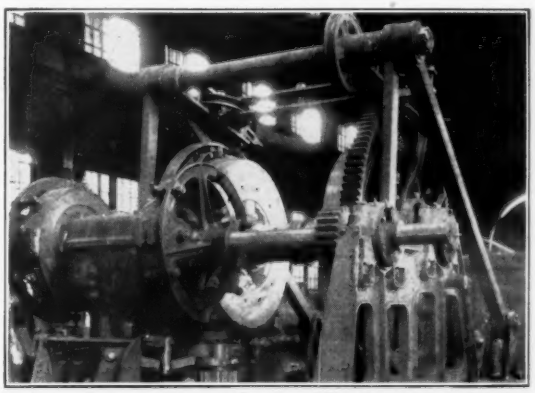


Courtesy of The Austin-Western Road Machinery Co.

Fig. 7—Close-up view of a turn table mechanism of an Austin-Western shovel, with shields removed to show clutches and brakes.

enable the operator to understand the matter of lubrication more intelligently, and appreciate its relation to efficient and economical operation.

An oil for this service must possess as high a degree of lubricating ability as possible, it must be heat resisting, have dependable seal-forming properties, as low a pour test as possible to insure ready flow on cold starting, and sufficient viscosity to assure of adequate lubrication regardless of operating conditions.



Courtesy of The Marion Steam Shovel Co.

Fig. 8—Deck view of the main operating machinery of a Marion Power Shovel, adaptable to gasoline, Diesel or electric power.

Lubricating ability, or as it is often termed, "oiliness", involves the extent to which an oil will be able to develop and maintain a lubricating film between moving parts. The higher this property, the greater will be the insurance against burnt-out bearings, scored cylinders, or the development of wear.

It is also important that an oil for such service should have high heat resisting ability, for this will be an indication of its resistance to decomposition, and the possible development of extensive carbonaceous residue.

In considering seal forming, one must remember that this will involve the extent to which the oil will prevent loss of compression, blow-by of combustible gases, or pumping of lubricating oil past the piston rings.

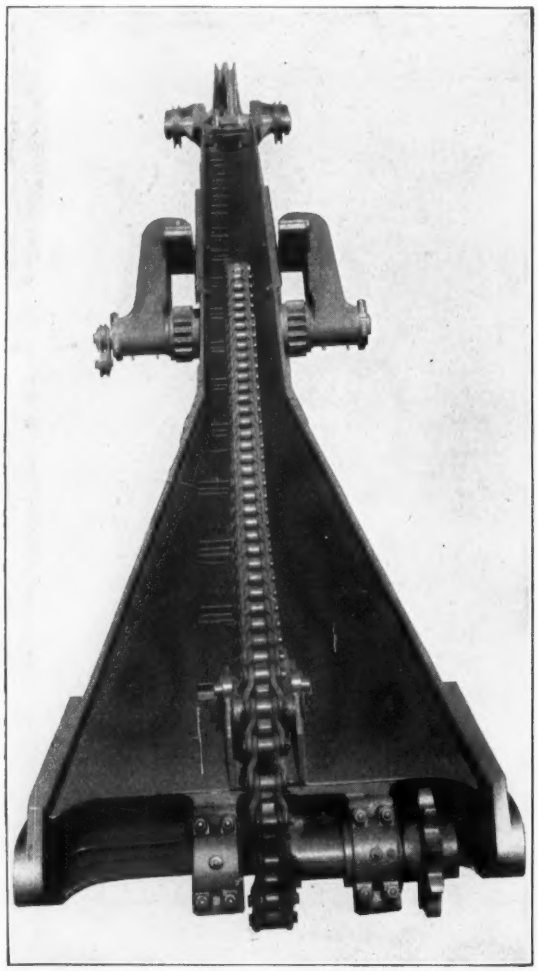
The pour test will indicate how the oil will act in cold weather. Obviously, the lower the pour test, or the temperature of relative congealment, the more dependable will be the lubricating oil. It must have sufficient fluidity to pass readily through the lubricating system and reach the bearings the instant the engine is started, whatever the temperature.

Viscosity, in turn, requires consideration from the viewpoint of the extent to which the oil will resist being squeezed out from between any of the wearing parts where pressures may be comparatively high.

Diesel Engine Drives

Successful lubrication of the Diesel engine in power shovel or construction machinery service will be dependent upon the use of properly

refined oil and its application or delivery in sufficient, though never excessive, amounts to the cylinders and bearings by means of a lubri-



Courtesy of Lima Locomotive Works, Inc.

Fig. 9—The Lima independent chain crowd designed for equal distribution of power to each shipper shaft pinion.

cating system capable of positive and dependable operation.

The custom of designing so as to enable use of the same oil for all the mechanisms of the engine, as is prevalent in automotive service, requires that the oil possess certain very definite characteristics.

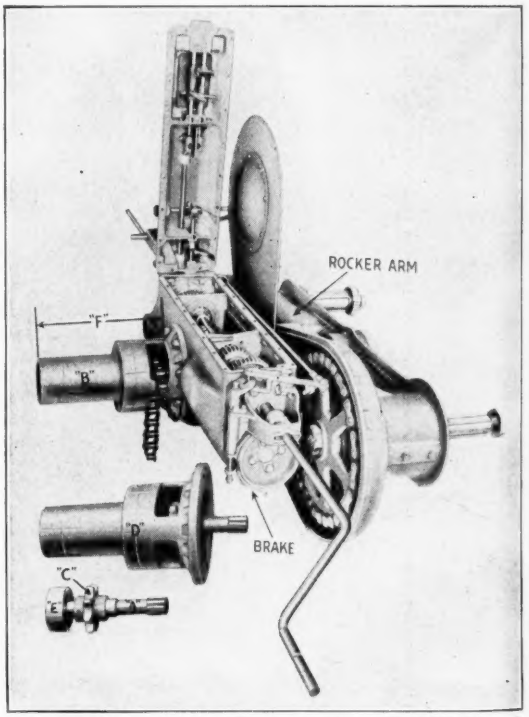
Among them is careful fractionation and absence of the lighter components, so that the resultant oil will not be so volatile as to require an undue quantity to maintain a suitable lubrication film, especially on the cylinder walls. Careful refining is also assurance of low emulsification tendency should the oil come in contact with water.

The viscosity should be such as to maintain a lubricating film of suitable thickness between the wearing surfaces under the prevailing temperatures of operation. Yet the oil should never be so heavy or viscous at these temperatures as to give rise to abnormal internal friction within itself, for this might readily develop excessive operating temperatures, especially on the engine bearings.

In company with viscosity, one must also consider adhesiveness and relative fluidity. A Diesel oil should always be sufficiently adhesive to resist being squeezed out from between the wearing surfaces when subjected to the normal pressures of operation. In turn, it should not congeal, or flow with difficulty at any of the lower temperatures to which it might be subjected during storage or operation.

It should be capable of spreading readily over the surfaces of the cylinder walls, not remaining in streaks or blotches, for otherwise suitable sealing of the pistons might be impaired.

The carbon forming tendency must be as low as possible, inasmuch as any breakdown which may occur when the oil is exposed to the intensive heat of combustion may develop a large amount of objectionable carbonaceous residuum, unless the product has been refined from a carefully selected crude stock.



Courtesy of The Austin-Western Road Machinery Co.

Fig. 10—The Austin-Western 6-Speed Transmission assembly with wheels and left hand rocker arm removed to show working elements and parts requiring lubrication.

Cylinder Lubrication Controls Wear

Cylinder and piston wear are usually the result of impaired lubrication. Cylinder wear

may result in loss of compression and reduced power. In other words, an engine with badly worn liners may be unable to carry full load. A most effective way by which excessive cylinder wear can be minimized is by use of proper lubricants as well as dependable means of application.

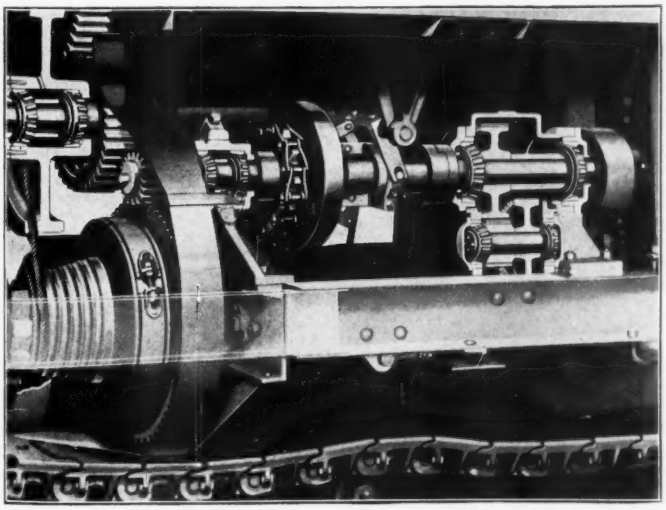
Lubrication of Diesel engine cylinders will also be influenced to a certain extent by the grade of the fuel and the completeness of combustion.

Experience has shown that lubrication should be positive and uniform, otherwise rings will be worn and may even become stuck, with an appreciable loss in compression. The wrist pins will also be affected. These parts on certain engines will be subjected to relatively high temperatures with but little opportunity for radiation of heat, unless cooled mechanically.

AIR POWER

Compressed air power has been subject to some study over recent years, leading to the development of the gas-air or Diesel-air machine. In such units compressed air is used instead of steam, the prime mover being the Diesel or gasoline engine directly connected to an air compressor of the four cylinder, single stage horizontal type.

A unique feature in the operation of the air compressor in such service is that no attempt is made to cool the air. On the contrary, it is heated to approximately 400 degrees Fahr., to utilize all the available energy. This is done by passing the discharge from the compressor through a suitable heat exchanger exposed to the exhaust gases from the engine.

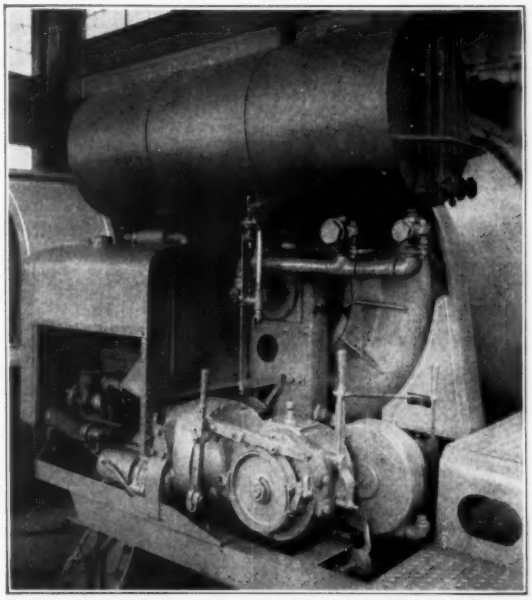


Courtesy of The Foote Company, Inc.

Fig. 11—Cutaway view of the operating mechanisms of the Multi-Foote Paver, showing relative location of gears, roller bearings and chain drives.

Compressor Cylinder Lubrication

Lubricating oils for this service must be refined to develop characteristics suited to the operating conditions. If the relation between these factors is thoroughly realized, maintenance of compressors and the routine of relubrication should be a comparatively simple matter.



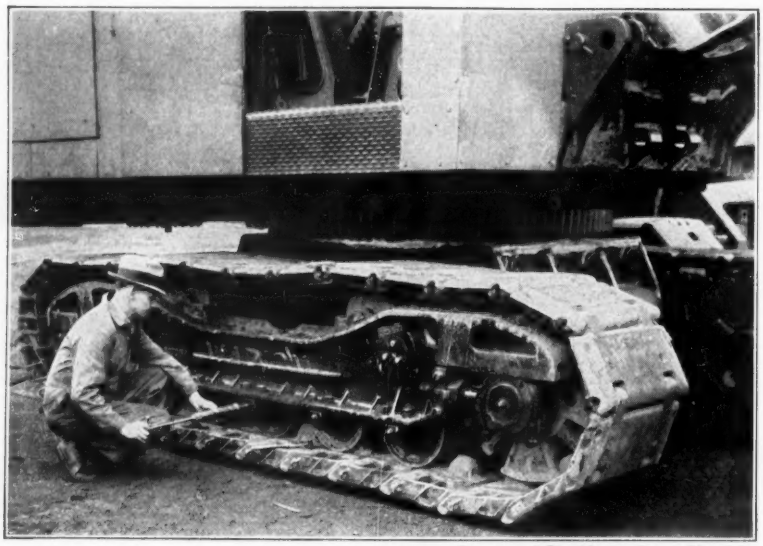
Courtesy of Chain Belt Company

Fig. 12—The Rex 2-Speed Moto-Mixer transmission and engine assembly.

All this, however, is predicated on initial selection of compressor oils which possess adequate viscosity at the operating temperatures and show as low a tendency as possible to vaporize and cause accumulation of hard carbon residues.

Breakdown will occur in any mineral oil, regardless of its base or nature, when subjected to heat, to result in vaporization and formation of carbon deposits. The extent to which this will occur, however, will depend on the length of time the oil is exposed to such heat. Consequently, the longer an oil remains within the compressor cylinders, the more carbon can be expected. There will, however, also be some siliceous material present in these deposits, especially if the air filters are not entirely effective, the binder usually being gummy matter from decomposed oil. In consequence it is advisable for a compressor oil to have a narrow range of distillation, with fairly low end point. The

viscosity must also be low, i.e., around an S.A.E. 10 to 20. Otherwise, instead of vaporizing cleanly it may break down, become sticky and collect dirt brought in by the air. The slower the breaking down process, or the greater the volume of oil involved, the more carbon will ultimately be developed.



Courtesy of The Marion Steam Shovel Co.

Fig. 13—Side view of the crawlers on the Marion clutch type power shovel showing method of lubricating the bottom rollers.

Carbon from petroleum oils may be formed in a hard mass, or it may be produced in the shape of dust and pass out with the air. Excessive carbon will often collect in pockets, elbows or on sharp edges and become mixed with dirt taken in by the air as well as with oil which has been vaporized in the cylinders, and later condensed at these points. Carbon deposits in compressor cylinders may become heated considerably above the temperature of the walls. Not only may this be hazardous, but also, hard carbon especially, is always a nuisance due to the possibility of accumulation on the valves and valve seats, and in the ends of the cylinders. This may cause valves to leak, frequently resulting also in cutting and scoring.

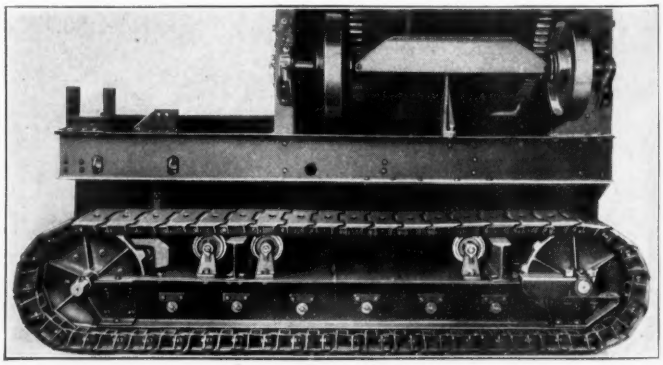
The adaptability of suitably refined, and closely fractionated pale filtered distilled oils for compressor service has been well demonstrated. They show the least tendency towards direct carbonization and the collection of carbonaceous matter; furthermore, any such direct carbon that may be formed through excessive use is of a light, fluffy nature.

On the other hand, carbon deposits formed from improperly refined or unsuitable oils are often of a hard flinty nature; being sticky and gummy, especially if they contain blends of cylinder stocks.

Viscosity of Compressor Oils

The importance of viscosity in a compressor oil must be fully realized due to its relation to piston seal and the efficiency of compression. If the oil is too light in body, i.e., low in viscosity, at the operating temperatures in the cylinder it may work past the piston rings to impair the seal. An air compressor oil, therefore, should have a viscosity high enough to sustain the weight of the moving parts, and form a proper seal between the piston rings and the cylinder walls, especially in the horizontal compressor.

On the other hand, a compressor oil should never be so heavy as to cause reduction in atomization or involve excessive internal friction. Furthermore, if too heavy an oil is used it will more easily collect any dust that may be present in the air and tend to bake on the hot surfaces to form carbon deposits. This is especially likely to happen when more oil has been applied than just sufficient to lubricate the wearing surfaces or where an air cleaner is not used.



Courtesy of The Foote Company, Inc.

Fig. 14—Side view of the tractor element of the Multi-Foote Paver, showing rollers, also part of the mixer operating mechanism.

Relation of the Pour Test

The pour test must also be carefully ob-

served in selecting an oil for air compressor service on highway construction machinery. Very frequently power shovels and other equipment are operated at temperatures down to zero and below. It is obvious, therefore, that on starting, the compressor oil must be capable of instantaneous flow; otherwise there will be the possibility of abnormal wear on piston rings and cylinder walls. This will, of course, lead to reduction of operating efficiency.

Lubricating Equipment

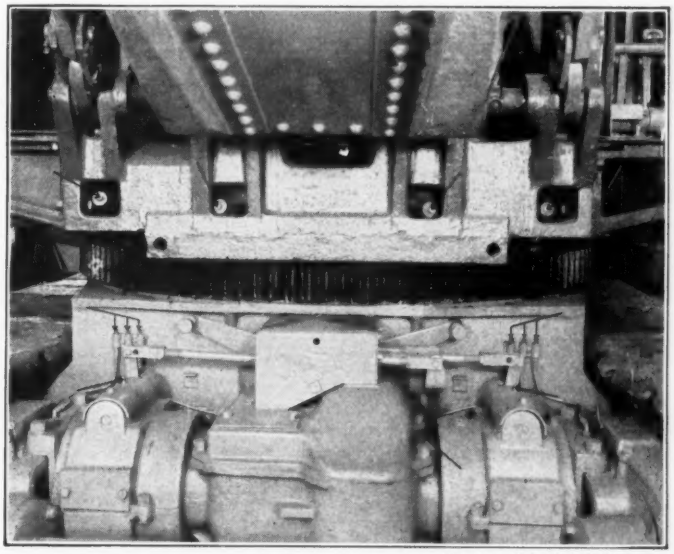
Compressor lubrication in the gas-air or Diesel-air machine is unique especially as applied to the swing and crowd units. These are lubricated by a type of hydrostatic lubricator, built as an integral part of the valve chest cover. It is interesting to note, in connection with this device, that the oil feed can be regulated by means of an auxiliary sight feed lubricator. As a result, the delivery of oil can be reduced to the required amount to permit effective lubrication, and yet prevent any possibility of the development of residual deposits in the air lines. In cold weather operation the oil is kept in a sufficient state of fluidity by means of the heated air in the valve chest.

MOTOR DRIVEN EQUIPMENT

Although the electric motor is not as widely used for the operation of highway construction machinery as the gasoline, Diesel or steam engine, it requires consideration from a lubrication point of view, due to its adaptability where power resources are available.

Motor lubrication requires knowledge of bearing construction. It must be positive and dependable, for any failure may lead to the possibility of the rotor coming in contact with the pole pieces, to cause burn-outs and shut down of the machine. The electric motor is, perhaps, the most delicate mechanism involved in materials handling equipment. Frequently, however, it is given no more consideration than the gears and wire ropes; although these latter, by virtue of their comparatively heavy construction and the nature of their lubrication, are far more capable of withstanding the duty imposed by temperature fluctuation, dust, dirt and water. In this type of operation one must realize that motor bearings have but a limited capacity for lubricant. There is consequently but little reserve, in case of trouble. Hence the need for regular inspection and re-lubrication.

Lubrication is provided for by means of ring oilers in the sleeve type bearing, or by pressure grease fittings in the ball or roller bearing. Where the ring oiler is employed oil must always be used as the lubricant. Normally, a straight mineral highly refined product of from 150-300 seconds Saybolt at 100 degrees Fahr. will suffice. In other words, an oil within the S.A.E. 20 to 30 range. Obviously such an oil should have as low a pour test as possible, especially where the machine is to be started and operated at comparatively low temperatures.



Courtesy of Link-Belt Company

Fig. 15—Looking directly under the shovel boom on a Link-Belt Crawler Gas Shovel. Arrows indicate the Alemite pressure grease fittings for automatic lubrication. The lower frame gears are enclosed in substantial housings and run in oil.

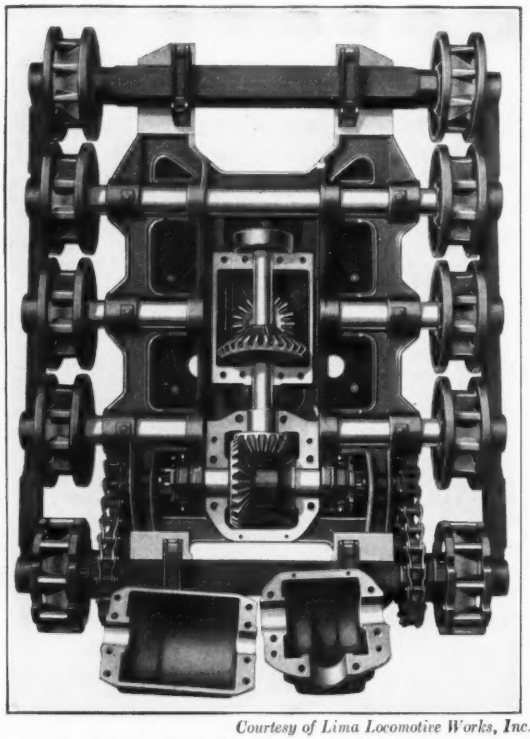
The amount of heat developed in a ring oiled bearing will be comparatively low. As a result, every care must be observed in the initial selection of the oil to insure against congealment or sluggish flow. Otherwise, damage to the bearings might occur, due to actual lack of lubrication, through failure of the oil to follow the rings especially when starting cold.

In the ball or roller bearing, grease lubrication will be most prevalent, due to its seal-forming properties. It is quite practicable, however, to design such a bearing for oil lubrication, by simply installing a suitable seal to prevent leakage. Greases, on the other hand, furnish better seals against the entry of dust, dirt and moisture.

GREASE LUBRICATED PARTS

In addition to some types of motor bearings there are, of course, many other bearings on the

average power shovel, etc., which require grease lubrication; also some types of chains. Because some of these have always been of rugged construction, the idea used to prevail that the cheapest grease available would give adequate protection. More recently, however, with improvements in design, and especially with the development of the ball and roller bearing, there has been a reversal of this trend, with the result that greases for highway materials handling machinery are selected quite as carefully as similar lubricants for automotive equipment. This practice has been aided by the adaptability of pressure lubrication and the positive results to be obtained from the hand or power type grease gun.



Courtesy of Lima Locomotive Works, Inc.

Fig. 16—View of a Lima Crawler element with gear cases removed. Note the relative location of the gears, chains and bearings of this unit.

The requirements involved in a grease for normal bearing service are not as exacting as in the case of engine or compressor oils. On the other hand, one should not go to the extreme in the belief that any cheap grease will suffice. Instead, study should be given to those essential characteristics of a grease, such as its melting point, consistency and the nature of the soap from which it has been made, to determine its adaptability to the operating conditions.

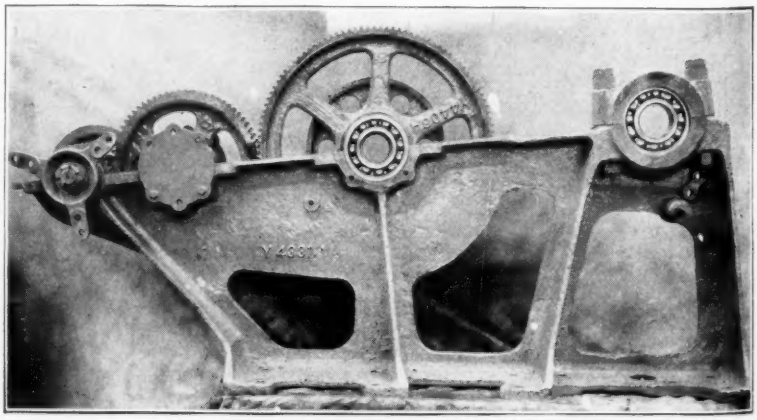
Bearing design is also a criterion; some types, for example, being exposed at the ends to allow complete flow of grease through the clearance spaces. For such service a grease must have considerable body to remain in position at these points and form a protective collar which will effectively prevent entry of dust or dirt into the bearing clearances.

Consistency or Body

This property in grease is indicative of the body or degree of hardness. It also serves as an indication of the texture. For example, cup grease will usually have a short fibery or buttery consistency, whereas a sponge grease will have a long fibery or spongy consistency. Greases within the same classification will vary in hardness, according to the amount and nature of soap used in their manufacture, as well as the method employed.

Consistency of comparatively non-fluid greases can be determined by use of the penetration method. It involves a device known as a penetrometer, equipped with a suitable cone which is allowed to drop into the product to be tested. The depth to which this cone penetrates a sample of grease over a period of 5 seconds at a definite temperature is read in terms of hundredths of a centimeter on a suitable scale, and reported as the penetration of the particular sample.

It is obvious that the harder the grease the less readily will it be penetrated by the cone. In other words, the depth of penetration will vary inversely with the approximate degree of hardness of the grease.



Courtesy of Bucyrus-Erie Company

Fig. 17—Power transmission unit on a Bucyrus-Erie shovel. The 1-piece cast steel frame forms the lower enclosure for the gears which run in oil. Note also the use of anti-friction bearings.

Melting Point or Drop Test

This property is indicative of the extent to which a grease will stand high temperatures. Wherever bearing temperatures may run comparatively high, the melting point of any grease to be used should be sufficiently above the average temperature to insure against actual fluidity and the possibility of separation of the soap from the oil. Certain greases cannot be heated very much above their melting point without the danger of such separation occurring.

The melting point of a grease is controlled by:

1. The nature of the fatty oil used
2. The nature of the base, and
3. The percentage of soap.

The nature of the base used, i.e., whether it is lime, caustic soda or other such material, influences the melting point more than do the other factors. Lime soap greases being of comparatively low melting point, i.e., below approximately 200 degrees Fahr., whereas soda soap products may show melting points as high as 400 degrees Fahr.

Operating Conditions

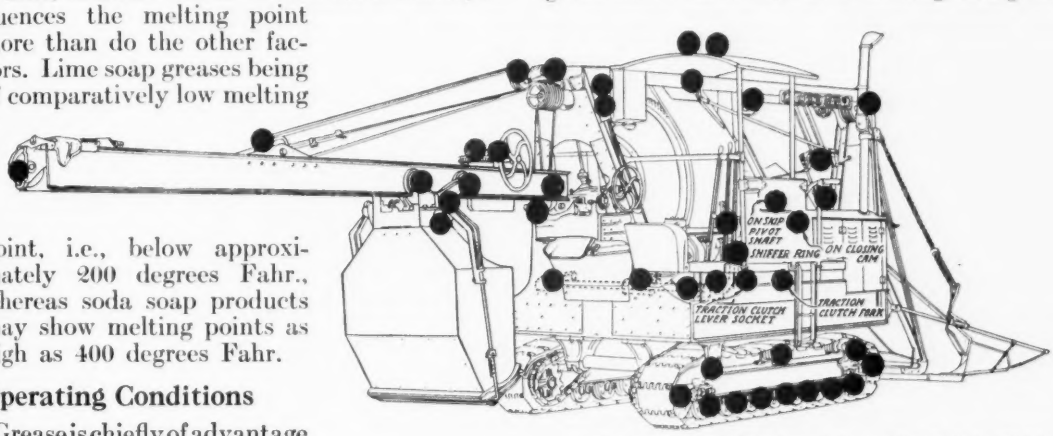
Grease is chiefly of advantage on construction machinery in lubricating those normally slow speed sleeve type bearings wherein high pressures may be involved and a comparatively heavy film of lubricant is desirable. More recently it has also been proved adaptable to certain types of ball and roller bearings where it is suited to a wide range of temperature and speed conditions.

On the plain or sleeve type bearings, grease lubrication is best suited to slow speed service, for a grease film is normally thicker than an oil film and will remain longer in the clearance spaces. This may not always hold true under comparatively high speeds, however, since the questions of pressure, bearing area and means of application must be considered.

Stability must also be given more careful study, for it is most important that a grease retain its intended homogeneity of mixture throughout its entire life; it must not separate, oxidize or form gummy residues. Unless a grease has been skillfully and scientifically made from the highest grades of ingredients, there may be a tendency towards lumpy separation of oil from the soap constituent. Such an occurrence will be especially likely in inferior products when stored over any length of time, or subjected to comparatively wide temperature variations. It will, of course, lead to impaired lubrication. Separation, however, may also be caused by the use of an excessive amount of heat in mixing, or by improper handling at this time.

Means of Lubrication

While the compression grease cup is still widely used on some types of external wearing parts of construction machinery, it is being supplanted by the pressure gun fitting by many builders. Both involve much the same principles of operation, although the pressure gun gives more assurance of a bearing being continually and completely filled with fresh, non-contaminated lubricant. At the same time, the act of re-lubrication insures more complete expulsion of old grease and any contaminating matter which it may have absorbed.



Courtesy of National Equipment Corporation, Koehring Division

Fig. 18—Lubrication diagram for the Koehring Paver with points of application indicated by black circles. There is extensive provision for grease lubrication on this machine. Instructions call for renewal of lubricant every day or every week, according to the location of the part.

The compression grease cup supplies grease to a bearing by virtue of a certain amount of pressure, which is exerted upon the grease by means of a screw down cap. While pressure is essentially the means of delivering grease to a bearing, the actual distribution within the clearance space may be aided by the motion of the moving element, capillary action, heat and vibration during operation.

Lubrication by means of the grease gun requires the use of some form of fitting or nipple equipped with a ball check valve to insure retention of the lubricant. By constructing the exterior of this fitting to conform with the design of the discharge nozzle of the pressure gun, it is practicable to render lubrication virtually automatic, and absolutely controllable upon attachment of the pressure gun.

Pressure lubrication in this manner is comparatively simple for it facilitates handling of grease in a cleanly and expedient manner. To attain maximum economy, however, the operator must have a clear understanding of the constructional details of the equipment involved and the capabilities of grease as a lubricant. The principle involved is largely that of periodic renewal by means of adequate pressure commensurate with the consistency of the grease. Re-charging of plain bearings with grease in this manner should be controlled or regulated by the flow from the ends of the bearings as it is forced through the clearance spaces and bearing grooves. This indicates when bearings have had enough, and it also enables the ready forcing out of deteriorated, contaminated or gummed grease, which otherwise would be a decided hindrance to effective lubrication. This is one of the chief advantages of grease lubrication by means of pressure lubricators.

GEAR REQUIREMENTS

In studying the lubrication of reduction gears in highway construction machinery, one must always realize that many of them will be exposed or inadequately housed. The advantages of proper housing are fully realized by the builders. Oftentimes, however, it is impracticable to apply such protection. In consequence, selection of lubricants must always be made with due consideration of this condition, and the possibility of alteration of the pitch line due to admixture of abrasive dust and dirt with the gear lubricant.

Pressure is another factor which must be considered in a gear installation. As a general rule tooth pressures will be comparatively high due to the small areas of contact. The more accurately the gears have been cut the more intense will be the pressure, inasmuch as line contact will more nearly prevail. Furthermore, this pressure will be constantly changing as the teeth mesh with each other. This will, of course, change the direction of application of the load. The effect on the structure of the teeth will not be serious as long as rolling motion is preserved by lubrication.

When wear occurs, however, there will be a tendency for the motion between the teeth to become sliding instead of rolling. This will cause more or less grinding between the teeth and bring about wear, especially if lubrication is not maintained in an effective manner. It will not be serious, however, if the gear lubricant possesses sufficient oiliness to reduce friction to a minimum. This characteristic is dependent upon the viscosity and the ability of the lubricant to adhere to the teeth and resist the pressures which are developed.

Temperatures likewise should be considered, In the normal operation of such machinery. gears will function at atmospheric temperature. As a result, the possibility of the gear lubricant being reduced in viscosity by abnormal heating is comparatively remote. Rather, one must study the effects which low temperature may have upon a gear lubricant in such service. Certain grades of lubricants will have a tendency to congeal to such an extent as to become brittle and crack. If the product has been properly refined, however, this should not be serious.

Straight mineral lubricants will generally be best adapted to the operating conditions mentioned heretofore. The average range in viscosity for service on exposed gears will vary from approximately 600 to 1000 seconds Saybolt at 210 degrees Fahr.; the higher viscosity being more nearly right to meet the usual requirements.

On enclosed gears, or certain types of chain drives, one must use a more fluid lubricant. The average chain drive in particular will involve comparatively low clearances between the connecting elements which go to make up the links. It is important, of course, that the lubricant be capable of penetrating to all surfaces of contact between these parts; otherwise, abnormal wear will take place. For this reason it will be advisable to use a lubricant of about the same viscosity as a heavy steam cylinder oil, i.e., in the neighborhood of 180 seconds Saybolt at 210 degrees Fahr.

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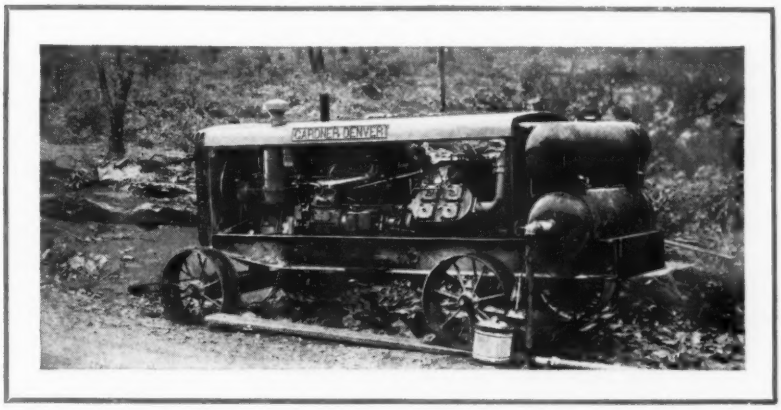
Here's how you can get both



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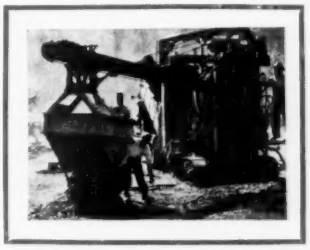

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THE TEXAS COMPANY

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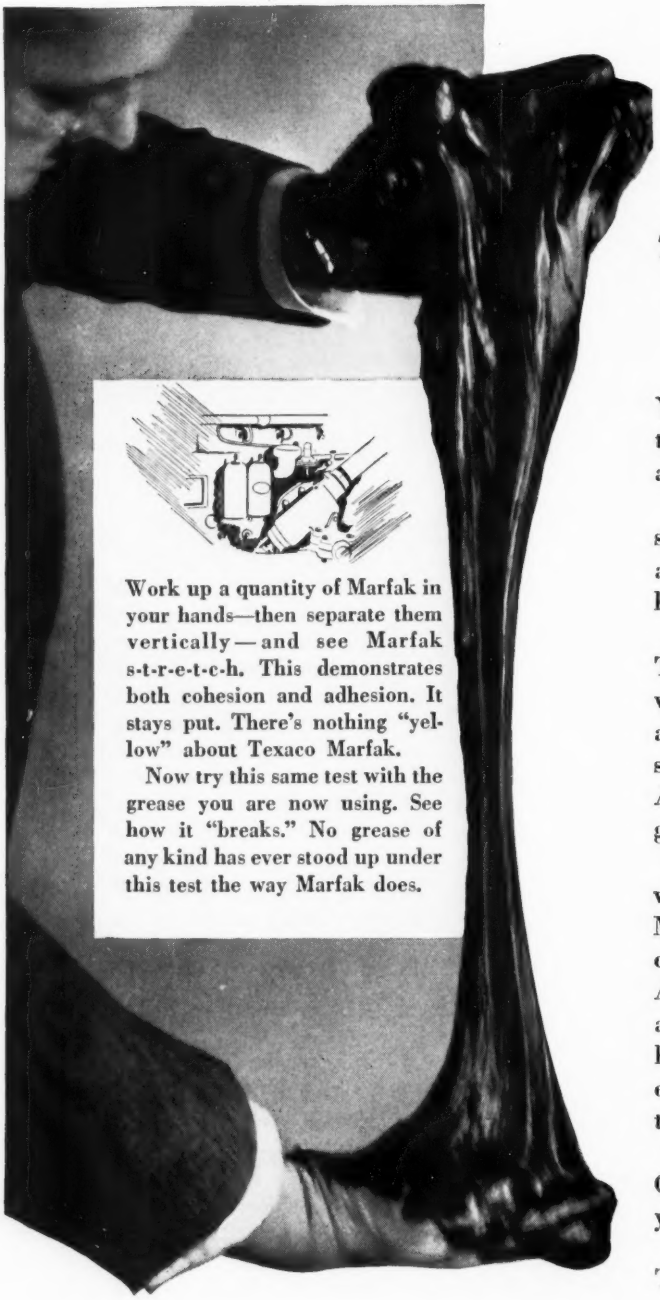

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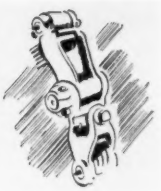
Now try this same test with the grease you are now using. See how it "breaks." No grease of any kind has ever stood up under this test the way Marfak does.



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